

character of the storm. It will be observed that the lowest barometer reading, 29.23, occurred at 4:30 a. m., indicating that at that time the center of the storm passed over that city:

30th.—Wind fresh from north to northeast during the morning with a shower and slowly falling barometer; thunder, with very heavy rain in the afternoon, with a northeast wind squall of 34 miles per hour. As the afternoon advanced the general conditions became threatening and the wind began to show a backing tendency to the northwest. The barometer fell slowly during the evening until 10 p. m., when a very rapid decline began, with wind increasing from the northwest. At midnight the wind velocity had risen to 45 miles per hour from the northwest and the barometer had fallen to 29.73.

31st.—Until 3:30 a. m. the wind continued from the northwest increasing steadily in force, with squalls, steady rain, and rapidly falling barometer. At 3:30 a. m. a terrific wind squall occurred, during which a velocity of 76 miles per hour was recorded for five minutes with an extreme velocity (one mile) of 80 miles per hour. From that hour there was a slow but perceptible decrease in the wind force, although heavy gusts and squalls continued, and the barometer fell until 4:30 a. m. At 4:05 a. m. the wind shifted from northwest to west, to southeast at 5:40 a. m., and to south at 8 a. m., with rapidly rising barometer. During the nine hours ending 3 p. m. the rainfall amounted to 5.41 inches. Great damage was done to roofs, etc., the streets being littered with debris. The damage to shipping was considerable; lighters were blown ashore, dredges went adrift, and two barges were stranded on the river front; railroad roadbeds were washed out and telegraph and telephone lines were prostrated, leaving the city without communication. The estimated damage in the city of Savannah was \$250,000, and rice plantations suffered to the extent of over \$150,000.

The storm was not severely felt at Charleston, S. C., and did not extend to Jacksonville, Fla.

THUNDERSTORM FORECASTS.

The thunderstorms of the 15th, 16th, and 17th in the Chicago district were accurately forecast. They were particularly severe in the vicinity of Chicago, and the forecasts were strongly commended by the local press. Severe squalls occurred on Lake Michigan the night of the 24th, causing the capsizing of two schooners at Egg Harbor, Wis., and the foundering of two barges in tow near Muskegon, Mich. Sufficient warning of this storm was given by the Chicago office, the forecast sent to all Lake Michigan ports on the 23d being as follows:

Variable winds, shifting to fresh and brisk northerly; thunderstorms to-night.—*H. J. Cox, Forecast Official.*

AREAS OF HIGH AND LOW PRESSURES.

During the month there were six highs and nine lows sufficiently well defined to be traced on Charts I and II. The principal points regarding their origin and disappearance, their duration, length of path, and velocity, will be found in the accompanying table. In making up the summary of lows No. IX was omitted as having too short and erratic a path to be considered in the monthly mean. In general the highs and lows of the month have been very indefinite and hard to follow on the weather maps. In Alberta and Assiniboia the reductions of barometer readings to sea level have been made by using the current temperature instead of the mean of a. m. and p. m. as in the United States. As a result of this there are very often fictitious highs in the morning and fictitious lows in the evening to the north of Montana. Some allowance has to be made for these conditions in tracing highs and lows.

Highs.—The general tendency of the highs has been to appear along the northern boundary of this country. Nos. I and IV could be traced from the Pacific coast. Nos. II, III, and VI began in the northwest, and V in the upper Mississippi Valley. Nos. I, II, and III disappeared off the north Atlantic coast, and V in the Middle Atlantic States, II off the south Atlantic coast, and IV in the lower St. Lawrence Valley.

Lows.—The lows of the month appeared to move along the

northern boundary like the highs. Nos. III, V, VI, VII, and VIII began near the north Pacific coast. No. IV was first noted to the north of Montana, No. I in the middle Mississippi Valley, and IX was a tropical storm which was first noted off the north coast of Florida morning of 30th, and disappeared in Alabama p. m. of September 1. This last storm gave the highest winds of the month, 80 miles an hour at Savannah, Ga. A full account will be found elsewhere. On the 12th, as storm V was passing along the lower Lakes a most extraordinary rainfall was experienced at Washington City. The rain came in torrents all day long, and at 8 p. m. 4.92 inches had fallen in twelve hours. This storm was surprisingly local in its occurrence, and seems to have been central about 2.5 miles from the capitol. The distributing reservoir in Georgetown measured 5.93 inches on a. m. of 13th, and the second reservoir, about 4 miles beyond, measured 5.44 inches. Alexandria, Va., about 8 miles distant, had but 2.16 inches. It is probable the severe rain did not extend more than 6 miles across. Great Falls, 16 miles distant, measured only 0.93 inch total fall from a. m. of 12th till a. m. of 13th, and Kensington, 9 miles north, had but 1.87 inch. This was an example of a sporadic rain distinct from any low area or secondary formation, and presents a most interesting example for study.—*H. A. Hazen, Professor.*

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
High areas.										
I.....	1, a. m.	33	120	11, p. m.	45	58	5,200	10.5	504	21.0
II.....	2, p. m.	45	100	7, a. m.	34	77	1,830	4.5	407	17.0
III.....	9, a. m.	48	110	15, a. m.	42	66	2,940	6.0	490	20.4
IV.....	14, p. m.	47	128	19, a. m.	48	72	2,840	4.5	631	26.3
V.....	18, p. m.	43	90	20, p. m.	39	78	960	2.0	480	20.0
VI.....	25, a. m.	52	104	29, a. m.	45	61	2,280	4.0	570	23.7
Total.....							16,110	31.5	3,082	128.4
Mean of 6 paths.....							2,685		514	21.4
Mean of 31.5 days.....									511	21.3
Low areas.										
I.....	†30, p. m.	37	88	2, p. m.	45	60	1,560	3.0	520	21.7
II.....	1, p. m.	43	104	6, a. m.	51	61	2,400	4.5	533	22.2
III.....	1, p. m.	49	122	7, a. m.	33	97	2,640	5.5	480	20.0
IV.....	4, p. m.	54	106	9, p. m.	48	55	2,530	5.0	524	21.8
V.....	7, a. m.	46	126	13, p. m.	52	65	3,480	6.5	535	22.3
VI.....	11, p. m.	47	117	15, a. m.	44	83	1,710	3.5	489	20.4
VII.....	19, p. m.	53	116	27, a. m.	47	64	3,480	7.5	464	19.3
VIII.....	25, a. m.	52	126	29, p. m.	51	68	2,400	4.5	533	22.2
IX*.....	30, a. m.	30	80	†1, p. m.	33	87	510	2.5	204	8.5
Total.....							20,190	40.0	4,078	169.9
Mean of 8 paths.....							2,524		510	21.3
Mean of 40 days.....									505	21.0

* Not included in final means.

† July.

‡ September.

RIVERS AND FLOODS.

General, and in some instances abnormally heavy, rainfall over the drainage areas of the principal rivers kept all streams, except the upper and middle Mississippi and Missouri rivers, at stages in excess of the usual summer conditions, and as a result navigation and logging were successfully carried on during the entire month of August, 1898.

On the rivers of the Atlantic coast and Gulf States, and on the Ohio and Tennessee rivers, the high stages were very beneficial to river traffic, but were, on the other hand, detrimental to riparian owners, overflowing their lands and doing considerable damage to crops. In the Ohio River a moderate flood prevailed from the 6th to 13th, and although timely warnings were issued, which enabled merchants to save merchandise, farmers were unable to remove crops and

much damage resulted thereto. While barge and coal-boat shipment was brisk, river construction work, which depends on low water, was practically suspended.

In the upper and middle Mississippi and Missouri watersheds ample rain fell, but it had no appreciable effect upon the rivers.

The highest and lowest water, mean stage, and monthly range at 117 river stations are given in the accompanying table. Hydrographs for typical points on seven principal rivers are shown on the Chart. The stations selected for charting are: Keokuk, St. Louis, Cairo, Memphis, and Vicksburg, on the Mississippi; Cincinnati, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

The following résumé of river stages in the respective streams is compiled from reports by the officials of the Weather Bureau at various river stations.

For fuller details see Monthly Bulletin of the River and Flood Service for August, 1898.—E. B. Garriott, Professor in charge Forecast Division.

Heights of rivers referred to zeros of gauges, August, 1898.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
<i>Mississippi River.</i>								
St. Paul, Minn.....	1,957	14	3.8	1,2,6	2.7	15,20	3.1	1.1
Reeds Landing, Minn.....	1,887	12	2.0	1	1.0	25-31	1.4	1.0
La Crosse, Wis.....	1,822	12	3.2	1	1.8	26-31	2.3	1.4
North McGregor, Iowa.....	1,762	18	2.7	1	1.2	30,31	2.1	1.5
Dubuque, Iowa.....	1,702	15	3.0	3	1.3	31	2.1	1.7
Leclaire, Iowa.....	1,612	10	2.2	17	0.9	31	1.4	1.3
Davenport, Iowa.....	1,596	15	3.5	18	1.6	31	2.4	1.9
Galland, Iowa.....	1,475	8	3.2	17,18	1.0	13	1.5	1.3
Keokuk, Iowa.....	1,466	14	5.2	18	1.4	12,13, 30,31	2.3	3.8
Hannibal, Mo.....	1,405	17	6.3	19	2.6	31	3.5	3.7
Grafton, Ill.....	1,307	23	7.2	20,21	3.8	14	5.1	3.4
St. Louis, Mo.....	1,264	30	12.3	4	6.4	31	9.2	5.9
Chester, Ill.....	1,189	30	9.6	5	4.1	31	6.8	5.5
Cairo, Ill.....	1,073	45	27.4	19	14.5	29,30	19.7	12.9
Memphis, Tenn.....	843	33	19.1	21	8.7	1	13.2	10.4
Helena, Ark.....	767	42	26.8	22	13.4	1	19.5	13.4
Arkansas City, Ark.....	635	42	26.2	24	15.0	1,2	21.9	13.2
Greenville, Miss.....	595	42	23.2	24,25	12.0	1,3	17.6	11.2
Vicksburg, Miss.....	474	45	25.8	25,26	13.5	2,4	19.5	12.8
New Orleans, La.....	108	16	7.4	29	4.1	3,4	5.6	3.3
<i>Arkansas River.</i>								
Wichita, Kans.....	720	10	2.6	9,10	1.2	27-31	1.7	1.4
Fort Smith, Ark.....	345	22	15.2	3	4.6	27	8.4	10.6
Dardanelle, Ark.....	250	21	15.0	5	4.4	29	8.6	10.6
Little Rock, Ark.....	170	23	13.2	14	5.9	31	10.0	7.3
<i>White River.</i>								
Newport, Ark.....	150	26	20.7	12	3.6	31	9.6	17.1
<i>Des Moines River.</i>								
Des Moines, Iowa.....	150	19	3.1	26-31	2.7	10-12	2.9	0.4
<i>Illinois River.</i>								
Peoria, Ill.....	135	14	5.7	19	4.1	1-4,15	4.7	1.6
<i>Missouri River.</i>								
Bismarck, N. Dak.....	1,201	14	5.4	1	3.0	31	4.1	2.4
Pierre, S. Dak.....	1,066	14	5.4	1	3.2	29-31	4.1	2.2
Sioux City, Iowa.....	676	19	9.8	1	5.7	30,31	7.4	4.1
Omaha, Nebr.....	561	18	10.5	1	7.5	31	8.9	3.0
St. Joseph, Mo.....	373	10	5.4	1	2.5	31	3.9	2.9
Kansas City, Mo.....	280	21	11.9	1	7.3	31	9.5	4.6
Boonville, Mo.....	191	20	10.9	1	6.4	31	8.4	4.5
Hermann, Mo.....	95	24	11.4	2	5.8	31	8.4	5.6
<i>Ohio River.</i>								
Pittsburg, Pa.....	966	22	12.9	12	2.9	18	6.8	10.0
Davis Island Dam, Pa.....	960	25	13.1	20	3.3	3,4	7.1	9.8
Wheeling, W. Va.....	875	36	17.5	21	4.8	4	8.7	13.2
Parkersburg, W. Va.....	785	36	16.9	22	6.2	1	10.2	10.7
Point Pleasant, W. Va.....	703	39	30.9	12	4.9	2	12.7	26.0
Catlettsburg, Ky.....	651	50	40.5	12	7.2	31	17.1	33.3
Portsmouth, Ohio.....	612	50	39.6	12	8.2	31	17.9	31.4
Cincinnati, Ohio.....	499	50	39.9	13	11.2	1	20.2	28.7
Louisville, Ky.....	367	28	14.2	15	6.0	1	8.6	8.2
Evansville, Ind.....	164	35	25.3	17	8.0	1	15.0	20.3
Paducah, Ky.....	47	40	23.0	18,19	6.8	1	13.2	16.2
<i>Allegheny River.</i>								
Warren, Pa.....	177	7	5.0	20	0.3	4	1.8	4.7
Oil City, Pa.....	123	13	6.6	19	0.8	1-3	2.3	5.8
Parkers Landing, Pa.....	73	20	8.0	19	0.8	2,3	2.3	7.2
Freeport, Pa.....	26	30	13.2	20	1.5	3	4.0	11.7
<i>Conemaugh River.</i>								
Johnstown, Pa.....	64	7	6.8	19	1.3	3	2.5	5.5
<i>Red Bank Creek.</i>								
Brookville, Pa.....	35	8	2.8	19	0.2	1-4	0.7	2.6
<i>Beaver River.</i>								
Ellwood Junction, Pa.....	10	14	5.5	19	0.0	31	1.1	5.5
<i>Cumberland River.</i>								
Burnside, Ky.....	434	50	24.6	10	1.3	31	5.8	23.3
Carthage, Tenn.....	257	30	19.9	18	1.7	31	6.4	18.2
Nashville, Tenn.....	175	40	24.4	11	2.4	31	9.7	22.0
<i>Heights of rivers above zeros of gauges—Continued.</i>								
Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
<i>Great Kanawha River.</i>								
Charleston, W. Va.....	61	30	31.0	11	4.5	19	8.8	26.5
<i>New River.</i>								
Hinton, W. Va.....	95	14	9.0	11	1.6	25	3.0	7.4
<i>Licking River.</i>								
Falmouth, Ky.....	30	25	8.6	12	1.0	31	3.5	7.6
<i>Monongahela River.</i>								
Weston, W. Va.....	161	18	6.0	11	— 1.0	30,31	0.6	7.0
Fairmont, W. Va.....	119	25	14.9	11	0.2	31	3.7	14.7
Greensboro, Pa.....	81	18	20.3	11	7.0	29-31	9.4	13.3
Lock No. 4, Pa.....	40	28	23.3	11	6.0	31	10.8	17.8
<i>Cheat River.</i>								
Rowlesburg, W. Va.....	36	14	9.4	11	3.0	1,2	4.2	7.4
<i>Youghiogheny River.</i>								
Confluence, Pa.....	59	10	7.4	10	1.5	31	3.7	5.9
West Newton, Pa.....	15	23	10.1	11	0.7	1	3.0	9.4
<i>Muskingum River.</i>								
Zanesville, Ohio.....	70	20	11.3	21	6.9	30	8.4	4.4
<i>Tennessee River.</i>								
Kingston, Tenn.....	534	25	11.1	13	1.8	27,28	4.5	9.3
Chattanooga, Tenn.....	430	33	15.8	14	3.9	31	8.1	11.9
Bridgeport, Ala.....	390	24	12.2	15	2.2	27,28	5.8	10.0
Florence, Ala.....	220	16	10.0	16	1.9	30	5.5	8.1
Johnsonville, Tenn.....	94	21	13.6	12	3.2	31	7.9	10.4
<i>Clinch River.</i>								
Spears Ferry, Va.....	156	30	10.8	11	0.4	25,31	3.3	10.4
Clinton, Tenn.....	46	25	21.0	12	4.0	27,31	8.4	12.0
<i>Wabash River.</i>								
Mount Carmel, Ill.....	50	15	3.0	10	1.6	29-31	2.0	1.4
<i>Red River.</i>								
Arthur City, Tex.....	688	27	13.7	6	5.0	26	7.7	8.7
Fulton, Ark.....	565	28	12.8	11	4.0	28-31	7.4	8.8
Shreveport, La.....	449	29	7.6	13-15	2.6	31	5.9	5.0
Alexandria, La.....	139	33	5.4	18,19	1.6	31	4.0	3.2
<i>Atchafalaya Bayou.</i>								
Melville, La.....	100*	31	22.3	28-30	14.6	8	18.4	7.7
<i>Ouachita River.</i>								
Camden, Ark.....	340	39	7.2	13	4.1	26,27,31	4.9	3.1
Monroe, La.....	100	40	6.3	1	2.0	30,31	3.7	4.3
<i>Yazoo River.</i>								
Yazoo City, Miss.....	80	25	8.8	15,16	1.5	31	2.8	7.3
<i>Chattahoochee River.</i>								
Columbus, Ga.....	140	20	15.8	28	2.9	25	7.8	12.9
<i>Flint River.</i>								
Albany, Ga.....	80	20	14.0	21	2.0	26	6.9	12.0
<i>Cape Fear River.</i>								
Fayetteville, N. C.....	100	38	29.2	22	2.3	11	9.8	26.9
<i>Columbia River.</i>								
Umatilla, Oreg.....	270	25	11.7	1	8.3	31	9.9	3.4
The Dalles, Oreg.....	166	40	18.5	1	12.5	28,31	14.9	6.0
<i>Willamette River.</i>								
Albany, Oreg.....	99	20	1.0	1-3	0.7	20-31	0.8	0.3
<i>Edisto River.</i>								
Edisto, S. C.....	75	6	4.9	31	2.2	10,11	3.2	2.7
<i>James River.</i>								
Lynchburg, Va.....	257	18	9.5	11	0.5	31	2.9	9.0
Richmond, Va.....	110	12	7.1	13	0.0	27-31	1.7	7.1
<i>Alabama River.</i>								
Montgomery, Ala.....	265	35	19.5	12	2.4	23,25,26	7.1	17.1
Selma, Ala.....	212	35	22.7	13	2.8	26	9.1	19.9
<i>Coosa River.</i>								
Rome, Ga.....	225	30	9.9	11	1.9	25	3.8	8.0
Gadsden, Ala.....	144	18	8.9	13	1.0	26,27	3.8	7.9
<i>Tombigbee River.</i>								
Columbus, Miss.....	225	33	2.4	12	— 3.5	28,29	— 1.4	5.9
Demopolis, Ala.....	155	35	11.5	14	— 1.0	25	3.4	12.5
<i>Black Warrior River.</i>								
Tuscaloosa, Ala.....	90	38	14.1	12	0.5	25	3.4	13.6
<i>Pedee River.</i>								
Cheraw, S. C.....	145	27	29.5	22	1.0	6,7,11	6.6	23.5
<i>Black River.</i>								
Kingstree, S. C.....	60	12	7.1	31	4.1	12	5.3	3.0
<i>Lumber River.</i>								
Fairbluff, N. C.....	10	6	4.4	31	1.1	1	2.6	3.3
<i>Lynch Creek.</i>								
Effingham, S. C.....	35	12	13.7	30	4.4	12	7.4	9.3
<i>Potomac River.</i>								
Harpers Ferry, W. Va.....	170	16	15.5	12	1.6	4	4.2	13.9
<i>Roanoke River.</i>								
Clarksville, Va.....	155	12	3.6	16	0.4	5	1.3	3.3
<i>Sacramento River.</i>								
Red Bluff, Cal.....	241	28	— 0.6	1-9	— 0.8	26-31	— 0.7	0.2
Sacramento, Cal.....	70	25	7.6	1-6	7.2	26-31	7.4	0.4
<i>Santee River.</i>								
St. Stephens, S. C.....	50	12	8.4	31	6.2	9	7.3	2.2
<i>Congaree River.</i>								
Columbia, S. C.....	37	15	5.0	20	1.6	4,5,7	2.7	3.4
<i>Watauga River.</i>								
Camden, S. C.....	45	24	25.1	21	4.0	4	10.2	21.1
<i>Savannah River.</i>								
Augusta, Ga.....	130	32	19.9	20	6.5	4	11.2	13.4
<i>Susquehanna River.</i>								
Wilkesbarre, Pa.....	178	14	6.0	27,28	0.0	1-3	2.9	6.0
Harrisburg, Pa.....	70	17	5.3	6	1.4	1,3	8.1	3.9
<i>Juniata River.</i>								
Huntingdon, Pa.....	80	24	6.5	5	3.0	2,3,5, 16-18, 24-31	3.5	3.5
<i>W. Br. of Susquehanna.</i>								
Williamsport, Pa.....	35	20	6.8	20	1.0	1,3,12, 13,17,18	1.9	5.3
<i>Waccamaw River.</i>								
Conway, S. C.....	40	7	4.7	31	1.5	1	3.0	3.3

* Distance to Gulf of Mexico. † Record for 80 days.